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ABSTRACT

The interaction among ethnicity, socioeconomic status (SES), mathematics achievement level, and gender on student beliefs about themselves as learners of mathematics was studied through in-depth interviews with high school students. One hundred high school students were interviewed. Half were: (1) African American or White; (2) female or male; (3) high-math or low-math achievers; and (4) residing in high and low SES communities. Dependent variables, based on student responses, were educational aspirations and mathematics self-concept, while demographic variables such as gender and ethnicity were independent variables. Findings reveal interactions of mathematics achievement by ethnicity, ethnicity by math achievement by SES, and gender by math achievement. The significant reported interactions involve mathematics achievement, yet mathematics coursework and achievement levels are not commonly studied when reporting socioeconomic, gender, and ethnic differences of mathematics attitudes. Males were more likely than females to attribute intrinsic constructs as reasons for their mathematics grades. Findings about African American students support research that dispels the myth that African American youth have little academic self-concept and that indicates that minority youth are not easily discouraged by low achievement. (Contains 4 tables and 26 references.) (SLD)

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A Study of The Interaction of Ethnicity, Math Achievement, Socioeconomic Status, and Gender on Math Attitudes of High School Students

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OBJECTIVES

The goal of this National Science Foundation Grant was to interview high school students in-depth to investigate the interaction between ethnicity, socioeconomic status (SES), math achievement/level, and gender on student beliefs about themselves as learners of mathematics. Specifically, this exploratory research study questioned students regarding constructs that are acknowledged as influencing mathematics learning. They are achievement motivation, career expectations, influence of teachers and parents, parental education and occupation, enjoyment of mathematics, self-esteem as a mathematics student, math stereotypes, mathematics utility/relevance, teacher expectations, and locus of control. The final objective was to generate hypotheses about the interaction of the student variables with the constructs that influence attitudes towards mathematics.

PERSPECTIVES

While a positive correlation between attitude toward mathematics and how likely one is to persist in studying mathematics has been documented (Armstrong, 1980; Boswell & Katz, 1980; Fennema & Sherman, 1978; Gwizdala & Steinback, 1990; Mathews, 1984; Meyer & Koehler, 1990; National Center for Education Statistics, 1991; Nelson, Knight, Kagan, & Gumbiner, 1980), studies examining the interaction between ethnicity, gender, mathematics achievement/level, and socicioeconomic status with attitudes toward mathematics are lacking (AAUW, 1991; Beaudry, 1992, Grant & Sleeter, 1986; Richman, Clark, & Brown, 1985). Researchers have charged that (a) differences in mathematics achievement and/or attitudes attributed to ethnicity or race may in fact be due to differences in the socioeconomic status (SES) of the school community (Hare, 1976; Lockheed, Thorpe, Brooks-Gunn, Casserly, & McAloon, 1985; Reyes & Stanic, 1985; Scott-Jones & Clark, 1986; Signer, Beaudry, & Bauer, 1995), (b) the failure to consider the correlation of all these variables has resulted in oversimplified analysis and perpetuation of gender and ethnic biases (Cohen, Pettigrew, & Riley, 1972; Coleman, et al., 1966; Fleming & Malone, 1983; Grant & Sleeter, 1986; Kohr, 1987; Signer et al., 1995; Stanic & Reyes, 1986), and (c) there is a reported need to acknowledge the effect of coursework and achievement/level with ethnic, socioeconomic, and gender differences when studying mathematics self-esteem (Coladarci & Lancaster, 1989; Fennema, 1977; Pallas & Alexander, 1983; Signer et al., 1995).

METHOD

This study used individual standardized open-ended interviews to collect appropriate information from Afro-American, and white students in low-SES and high-SES school communities in the New York City area. The interviews consisted of 23 questions. Each

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interview lasted 45 minutes. The interviews were conducted by students enrolled in either a masters program in education or a doctoral program in psychology. The interviewers were instructed on how to ask probing follow-up questions at appropriate places by university professors (mathematics education and psychology). All students were asked the same questions, in order to minimize bias and interviewer effects. The interviews were tape-recorded for later analysis.

Data Source

One hundred secondary students were interviewed in this study. Half the students were (a) Afro-American or white, (b) female or male, (c) high-math or low-math achievement/level, and (d) residing in a high-SES or low-SES school community. The SES determination was made by the percent of students in the school community who participate in the federally funded free or reduced lunch program. It was necessary to include the elementary and junior high school students in this determination because students who qualify for the federal lunch program in high school do not participate because they are embarrassed to do so or they do not eat lunch at school. For the purposes of this study, categories of low- and high-SES were determined as follows: (a) low-SES school community more than 80% and (b) high-SES school community less than 20%.

Mathematics achievement/level referred to the type of mathematics courses the students were enrolled in during high school. High achievement/level referred to regents courses and low achievement/level referred to non-regents courses. The regents diploma reflects a more rigorous, academic, college preparatory curriculum. A non-regents curriculum tends to focus on preparing students for admission to a two year college program or the working environment. The profile of a student enrolled in a non-regents level mathematics course includes students who have (a) previously shown difficulty in understanding mathematical principles and concepts, (b) not been successful in passing a New York State Regents Examination, and (c) poor academic self-esteem and attitudes toward school.

At the conclusion of the study, the researchers reviewed the interviews. Based on their interpretations, responses to each question were coded. Initially, chi-square analyses were performed for the purposes of data screening. Based on these results, coded responses were dichotomized and three dependent variables were selected.

Dependent Variables

An *educational aspirations* variable was created based on the students' responses to the question, "How far in school do you think you will get?" Academic aspirations were classified as either "less than college" or "college or beyond." Another dichotomous dependent variable was based on yes/no responses to "If given the opportunity would you take more advanced math courses?" This variable was assumed to represent the students' *academic aspirations in mathematics* .

A *mathematics self-concept* variable was based on the students' responses to "What do you think is the reason for your math grades?" This variable was dichotomized based on concepts related to locus of control. One classification, similar to internal locus of control, included responses interpreted as "ability and/or effort determines math grades." Responses that seemed related to external sources influencing math grades (i.e., liking the class or the teacher) were included in the other category.

Independent variables

Several dichotomous demographic variables (i.e., Gender, Ethnicity) were considered. Because the sample included only Afro-American and white students, a dichotomous variable was appropriate. Socioeconomic status (SES) was based on the socioeconomic status of the school community and classified as "High" or "Low." The

students' Math Achievement was also classified as High or Low based on what mathematics classes the student attended. Job Utility was based on yes/no responses to "Is it important to know math to get a good job?" It was believed that these career perceptions might influence the dependent variables, especially those concerning academic aspirations. Other variables were considered for analysis; however, they were omitted because they were either highly intercorrelated with other independent variables or not correlated to the dependent variables.

Data Analysis

Because the variables were dichotomous, loglinear modeling and logistic regression were used to determine which independent variables were most strongly related to the dependent variables of interest. Loglinear models were used specifically to investigate interactions among the independent variables. Procedurally, as higher level (three-way and four-way) interactions failed to reach the $\alpha = .05$ criterion for statistical significance, they were removed from the loglinear model. This reduction process continued until only statistically significant effects were included. These models were considered valid as long as no hierarchical confounds existed (i.e., two-way interactions in the absence of their main effects) and as long as model fit statistics were adequate. In cases where statistically significant interactions were present, odds ratios (OR) were produced for descriptive purposes. In cases where all interactions were not statistically significant, a logistic regression model was solved. Independent variables were also dropped from these logistic models when they failed to reach statistical significance at the .05 level.

RESULTS

Educational Aspirations

A significant Math Achievement by Ethnicity interaction was detected ($\chi^2 = 6.32$, $p = .0120$) for educational aspirations. All other two-way and higher-order interactions failed to reach statistical significance at the .05 level. Furthermore, the main effects of Job Utility, SES, and Gender were not statistically significant. Table 1 shows the Odds Ratios for these results and indicates that Low Achievement Whites were the least likely to have educational aspirations to attend college while High Achievement Whites were 13.71 times more likely to anticipate a college education. Interestingly, Low Achievement Afro-Americans were 3 times more likely to expect to attend college than Low Achievement Whites. However, by taking the ratio of the Odds Ratios in Table 1, it was revealed that High Achievement Whites were 2.09 times more likely to envision themselves attending college than High Achievement Afro-Americans.

Table 1. Likelihood to Plan a College Education.

Math Achievement	Ethnicity	Likelihood	Odds Ratio
Low	White	0.17	1.00
Low	Afro-American	0.50	3.00
High	White	2.29	13.71
High	Afro-American	1.09	6.55

Note. The group with the lowest likelihood was assigned an Odds Ratio of 1.00 and is used the base group to which other Odds Ratios are calculated.

Academic Aspirations in Mathematics

A significant three-way (Ethnicity by Math Achievement by SES) interaction was detected ($\chi^2 = 5.84$, $p = 0.0156$) for the academic aspirations in mathematics variable. All other three-way and higher-order interactions were not statistically significant. A statistically significant Gender by Math Achievement interaction was also detected ($\chi^2 = 4.94$, $p = 0.0262$). No other two-way interactions were statistically significant. Also, the main effect of Job Utility and its interactions with the other independent variables were not statistically significant. Therefore, Job Utility and its interactions were dropped from this analysis.

Table 2 shows the odds ratios for the three-way interaction and reveals that the Low Achievement, High SES Afro-American, the Low Achievement, Low SES White, and the High Achievement, High SES White students were the least likely to want more advanced courses in mathematics. Possibly, the White, High SES students were enrolled in high level courses and felt that they have already enrolled in an adequate number of advanced courses. By contrast, the Lower Achievement level for the other two groups may have influenced their perception of what an advanced math course entails. Interestingly, Afro-American students with Low Achievement and Low SES as well as High SES, High Achievement Afro-Americans were over 7 times more likely to show interest in advanced math courses. Thus, it appears that SES increases the aspirations of High Achievement Afro-Americans while SES does little to influence the aspiration of White students regardless of their achievement level. Furthermore, because Low Achievement, Low SES Afro-American students reported an extreme desire to take more advanced math courses, there is the possibility that their wishes stem from a perception that they have been denied the opportunity to take such courses.

Table 2. Likelihood to Desire More Advanced Math Courses for the SES by Math Achievement by Ethnicity Interaction.

SES	Math Achievement	Ethnicity	Likelihood	Odds Ratio
Low	Low	Afro-American	11.00	7.86
Low	Low	White	1.50	1.07
Low	High	Afro-American	2.67	1.90
Low	High	White	2.67	1.90
High	Low	Afro-American	1.40	1.00
High	Low	White	2.00	1.43
High	High	Afro-American	10.00	7.14
High	High	White	1.40	1.00

Note. The group with the lowest likelihood was assigned an Odds Ratio of 1.00 and is used the base group to which other Odds Ratios are calculated.

Table 3 displays the odds ratios for the Gender by Math Achievement interaction which shows that High achievement females were the least likely to desire more advanced course in math. Interestingly, Low Achievement students regardless of their gender were about equally likely to desire more advances courses in math. However, High Achievement Males were over 19 times more likely to desire more advanced math courses than their female counterparts.

Table 3. Likelihood to Desire More Advanced Math Course for the Math Achievement by Gender Interaction.

Math Achievement	Gender	Likelihood	Odds Ratio
Low	Male	2.00	1.83
Low	Female	1.75	1.60
High	Male	21.00	19.25
High	Female	1.09	1.00

Note. The group with the lowest likelihood was assigned an Odds Ratio of 1.00 and is used the base group to which other Odds Ratios are calculated.

Math Self-Concept

No statistically significant interactions among the independent variables were detected when analyzing the math self-concept dependent variable. Thus, a logistic regression model was performed. The effects of SES and ethnicity also failed to reach statistical significance and were removed from the logistic model. Table 4 shows the Odds Ratios of the subsequent model. The results indicate that males were 4.35 times more likely to believe that their ability and effort was a determining factor for their math grades while females were more likely to believe that their grades were attributable to more external factors. Also, those who believed that math is important to get a good job were 3.49 times more likely to believe that ability and effort influenced their math grades.

Table 4. Logistic Regression Results for Likelihood to Believe Achievement and Effort Cause Math Grades

Variable	Odds Ratio	Description
	1.00	Math is **NOT** important to get a good job
Job Utility	3.49	Math is important to get a good job
	1.00	Female
Gender	4.35	Male
	1.00	High Math Achievement
Math Achievement	2.96	Low Math Achievement

Interestingly, Low Achievement students were 2.96 times more likely to attribute their math grades to ability and effort. Although this result may seem counter-intuitive, it is consistent with the notion that an individual's "entity theory" concerning aptitude and achievement serves as a motivational process (Dweck ,1986). To elaborate, low achieving students often believe that their ability level is fixed and is the cause of their failures. Therefore, they avoid challenges and develop a "helpless" orientation toward school-related topics. Unfortunately, this belief in

their innate lack of ability perpetuates a cycle in which their achievement level can never improve. Therefore, they are cognizant that their low achievement and low effort is the cause of their grades; however, they feel helpless to change it.

CONCLUSIONS

This study explored the interaction of ethnicity, math achievement, socioeconomic status, and gender on math attitudes of high school students. Results reveal interactions of math achievement by ethnicity, ethnicity by math achievement by SES, and gender by math achievement. Most interestingly, the significant reported interactions involve math achievement. Yet, math coursework and achievement/level is not commonly studied when reporting gender, ethnic, and socioeconomic differences of math attitudes.

While this study verified previous findings that males are more likely than females to attribute intrinsic constructs (ability and effort) as reasons for their math grades, this study also reports interesting findings not previously explored. Specifically that (a) Afro-American high school students in low level math classes are three times more likely to anticipate attending college than their white counterparts and (b) Afro-American students enrolled in low level math courses in low SES high schools and Afro-American students enrolled in high level math courses in high SES high schools are the most likely to desire enrollment in more advanced math courses. These findings support the research that dispels the myth that Afro-American youth have little academic self confidence and support the research that minority youth are not easily discouraged by low achievement. Lastly, this study confirms previous findings concerning female student enrollment in advanced math courses. Of particular concern was the finding that female students enrolled in high level math courses were the least likely to desire further enrollment in these types of courses.

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